DTIC FILE COPY

AD-A178 567

Assessing the Personal Discount Rate

Roy D. Nord and Edward J. Schmitz

Manpower and Personnel Policy Research Group
Manpower and Personnel Research Laboratory

**DTIC
SELECTED
APR 0 3 1987
D**

ari

U. S. Army

Research Institute for the Behavioral and Social Sciences

March 1985

87   4   ᵔ   ᵔᵔ

U. S. ARMY RESEARCH INSTITUTE

FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the

Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Technical Director

L. NEALE COSBY
Colonel, IN
Commander

Technical review by

Hyder Lakhani
Rebecca Pliske

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARI Technical Report 673	2. GOVT ACCESSION NO. ADA 178567	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* ASSESSING THE PERSONAL DISCOUNT RATE		5. TYPE OF REPORT & PERIOD COVERED October 1984-March 1985
		6. PERFORMING ORG. REPORT NUMBER --
7. AUTHOR(s) Roy D. Nord and Edward J. Schmitz		8. CONTRACT OR GRANT NUMBER(s) --
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 20162722A791 211 3100
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		12. REPORT DATE March 1985
		13. NUMBER OF PAGES 36
14. MONITORING AGENCY NAME & ADDRESS*(If different from Controlling Office)* --		15. SECURITY CLASS. *(of this report)* Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --
16. DISTRIBUTION STATEMENT *(of this Report)* Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)* --		
18. SUPPLEMENTARY NOTES --		
19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)* Discount rate Personal discount rate Reenlistment Logit analysis Logistic models		

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This paper reviews research on the estimation of the personal discount rate (a key factor in evaluating the effects of changes in retirement programs) and presents results from recent Army Research Institute research on this issue. According to this research, the discount rates being used in economic models are likely to be incorrect. There is evidence that the discount rate applied to retirement benefits may be much lower than assumed. Retirement policies favoring present pay over future benefits may qualitatively change the composition of people remaining in the force.

DD FORM 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Assessing the Personal Discount Rate

Roy D. Nord and Edward J. Schmitz

Submitted by
Curtis Gilroy, Chief
Manpower and Personnel Policy Research Group

Approved as technically adequate
and submitted for publication by
Joyce L. Shields, Director
Manpower and Personnel
Research Laboratory

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
Department of the Army

March 1985

iii

ARI Research Reports and Technical Reports are intended for sponsors of R&D tasks and for other research and military agencies. Any findings ready for implementation at the time of publication are presented in the last part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

Accesion For		
NTIS CRA&I	✓	
DTIC TAB	☐	
Unannou ced	☐	
Justification		
By		
Distribution /		
Availability Codes		
Dist	Avail and / or Special	
A-1		

DTIC
COPY
INSPECTED
6

An important concern of the Manpower and Personnel Policy Research Group of the Army Research Institute for the Behavioral and Social Sciences (ARI) is the development of more effective methods to evaluate the effects of compensation policies on the enlistment and retention of soldiers. This report reviews past research concerning the personal discount rate, an important factor in determining the effect of retirement programs on retention behavior, and documents a current research effort toward estimating the personal discount rate.

EDGAR M. JOHNSON
Technical Director

EXECUTIVE SUMMARY

Requirement:

Previous research on the personal discount rate (PDR) was reviewed. A survey was conducted to replicate the findings of one influential study and to test the effect of an alternative instrument on estimates of the PDR.

Procedure:

Questions were fielded as part of the 1983 Army Research Institute's (ARI) Exit Survey. The results were analyzed using cross-tabulations and a binomial logit model.

Findings:

1. Estimates of the PDR were found to be highly sensitive to the design of the instrument used to elicit them.

2. Results of the ARI research are generally in agreement with those of previous research with respect to the directional effect of individual characteristics on the PDR.

3. ARI's estimate of the PDR of soldiers was markedly lower than the estimates currently used in reenlistment models.

4. If the ARI rates are correct, current models will substantially underestimate the negative effect on reenlistment of reductions in military retirement programs.

Utilization of Findings:

Planners and policymakers should exercise great caution when considering changes in military retirement programs. A key component of the models currently used to project the effects of such changes is unreliable; as a result, major changes in retirement benefits could result in large, unintended shifts in the composition and effectiveness of the force.

ASSESSING THE PERSONAL DISCOUNT RATE

CONTENTS
_____

LIST OF TABLES

LIST OF FIGURES

ASSESSING THE PERSONAL DISCOUNT RATE

INTRODUCTION

Military retirement costs have grown dramatically in the last 20 years in both absolute terms (from $1.2 billion to $16.8 billion) and relative terms (from 2% to 6% of the Defense budget). This trend has led to a variety of proposals to reduce retirement benefits. Such reductions offer a straightforward means of obtaining substantial cuts in personnel costs. However, responsible evaluation of the merits of these proposals requires careful consideration of their long-term effects on the composition and structure of the Army.

The military retirement system performs as both a compensation mechanism and a force management tool (Coffey, 1983). Recent analyses (Dale & Hill, 1984) have demonstrated that military retirement is a significant factor in bringing the lifetime earnings of military officers up to parity with their civilian counterparts. Thus, cuts in retirement pay could destroy career earnings comparability and substantially reduce the attractiveness of the Army as a career, particularly to those individuals who could command the highest salaries as civilians. It is therefore essential that, prior to implementing major changes in compensation policies, the effects of such changes on individual enlistment and reenlistment decisions be understood. To evaluate these effects, two questions must be answered:

1. What are the relative preferences of soldiers for reductions (or increases) in current pay over reductions (or increases) in retirement benefits?

2. How do these preferences vary among soldiers with differing characteristics?

The most common measure of these preferences is the "personal discount rate" (PDR), and estimates of this quantity play a critical role in the models used for policy analysis (see, for example, Warner, 1981). The remainder of this paper examines several approaches to the problem of estimating the PDR and presents results that highlight the extreme variability of these estimates.

The paper is divided into five sections. The first section provides a definition of the PDR and explains its relevance to the problem of predicting the effects of alternative compensation policies. The second section describes three methodologies for estimating the PDR and presents a range of results obtained by previous studies using each approach. The third section outlines the purposes, sample characteristics, and basic results of the Army Research Institute (ARI) research. The fourth section provides a brief review of the statistical methodology used, describes the results of the analysis, and compares the results to the findings of two earlier studies. The final section examines the implications of the variations across studies, notes important limitations on the reliability of conclusions based on any of these analyses, and suggests some promising directions for further research.

1

DEFINITION AND RELEVANCE

The PDR is simply a measure of the extent to which a person prefers current to future income.[1] More specifically, the annual real PDR of an individual is the rate of interest that will make the individual indifferent between a payment of $X at time t and a secured promise of a payment of $X plus accumulated interest at some future time t + k, where a dollar at time t is assumed to be equal in value to a dollar at time t + k.[2] The difference between the PDR and the market interest rate is that a person's PDR is influenced by his or her preferences for current versus deferred income, while the market rate (or rates) faced by an individual is determined by external forces. It is important to note, however, that the two rates are closely linked by the fact that the primary means for an individual to manage his or her flow of income (or consumption) is by borrowing or saving at the market rate. As we shall see later, under certain economic assumptions, an individual's PDR will always be equal to the rate at which he or she can borrow (or lend).

The higher an individual's discount rate, the more strongly he or she prefers current to future income and, conversely, the less he or she cares about changes in the expected value of future income. Therefore, if soldiers tend to have PDRs that are higher than the interest rate at which the government can borrow money, then it should be possible to make changes in military compensation that would be both cheaper for the government and preferred by Army personnel. (In effect, such a differential would mean that a dollar of deferred compensation costs the government more than it is worth to the soldier, and both the government and the soldier would prefer a plan which reduced retirement benefits and increased current pay.)

If it were possible, this would clearly be an attractive policy alternative. On the other hand, if good soldiers tend to have low discount rates (and if these rates figure prominently in the stay-or-leave decision), then a significant reduction in retirement pay, even if accompanied by increase in current pay, could cause a substantial decrease in reenlistments among good soldiers.

---

[1]This definition varies considerably, depending on the practitioner who employs it and the nature of the phenomenon it describes. In this case, we wish to describe the effects of variations in compensation policies on enlistment and reenlistment rates. We are not concerned with how a soldier chooses to dispose of his or her income (i.e., whether he or she saves or spends it), but only with when he or she prefers to receive it. Thus, while a strict definition of the PDR would focus on consumption streams, we will be interested only in preferences over income streams.

[2]All the rates referred to in the remainder of the paper should be assumed to be real rates--that is, net of inflation. This is done to avoid confusion and (to the extent possible) to separate the problem of assessing discount rates from that of evaluating the way people perceive and respond to risk and uncertainty.

MEASUREMENT ISSUES AND LITERATURE REVIEW

Before examining the various methods used to measure the PDR, it will be useful to summarize two basic concepts that underlie all of these approaches-- the idea of "present value" and the basic economic model of individual choice.

The present value to an individual of a stream of benefits from time 0 to time T is defined by equation 1:[3]

$$PV(B) = \sum_{t=0}^{T} [B_t (1 + r)^{-t}] \tag{1}$$

where

PV(B) is the present value of the stream to the individual,

B_t is the value (in constant dollars) of benefits received at time t, and

r is the individual's PDR at time 0.

Thus, if an individual's annual discount rate is 10%, then the present value of an annuity providing \$1,000 now and \$1,000 (in constant dollars) for the next 2 years is

$$
\begin{aligned}
PV &= 1,000(1.1)^{-0} + 1,000(1.1)^{-1} + 1,000(1.1)^{-2} \\
&= 1,000 \quad + \quad 909 \quad + \quad 826 \\
&= \$2,735.
\end{aligned} \tag{2}
$$

The economic model of individual choice among alternative streams of consumption is based on five assumptions:

1. Individuals are utility maximizers.

2. Individuals always prefer more consumption to less.

3. No bequests are allowed (i.e., the utility gained from receiving or passing on an inheritance is not a factor in the choice).[4]

---

[3]In the interest of clarity, we use annual compounding throughout the paper. If one assumes continuous compounding, the percent value formula becomes:

$$PV(B) = \int_{0}^{T} B_t e^{-rt} \, dt$$

where e is the base of the natural logarithms.

[4]This assumption considerably simplifies the exposition of the decision problem, but does not materially affect the issues with which we are concerned in this paper.

4. Savings are costless (or, equivalently, all forms of saving are equally costly).

5. Utility is a function of consumption only (i.e., the utility generated by savings is realized only when the savings and/or earnings on them are consumed, and the choice among alternative forms of saving [e.g., between self-managed investments and contributions to a pension fund] is solely determined by the comparative monetary yields of the alternatives).[5]

If these assumptions are satisfied, then an individual with a choice among alternative consumption streams will select the stream that solves the following problem:

$$\text{Maximize} \quad U(C_0, C_1, ---, C_T)$$

$$\text{subject to:} \quad \sum_{t=0}^{T} \left\{ C_t (1 + i)^{-t} \right\} = \sum_{t=0}^{T} \left\{ Y_t (1 + i)^{-t} \right\} \quad (3)$$

where

C_t = consumption in period t;
Y_t = income in period t; and
i   = the market rate of interest.

In other words, the individual will maximize the utility of consumption over his or her entire time horizon, subject to the constraint that the present value of the resulting pattern equals the present value of total income.

Note that to solve this problem at any given period t, the individual must know, in the deterministic case, his or her future income in every period $t = (t + 1, ---, T)$ with certainty.[6] In addition, the individual must know the shape of the utility function U over its entire range, and the parameters of U must remain constant over time. (Some of the effects of failing to satisfy these assumptions will be explored in the fifth section of this report.)

Attempts to assess the PDR can be grouped into three methodological categories: market rate studies, implicit rate studies, and direct assessment studies. The limitations of each approach are discussed below. Table 1 presents a summary of the results of a selection of studies using each alternative.

---

[5]Assumptions 4 and 5 are not generally made explicit. We do so here because (a) if these assumptions are satisfied, then the choice over income streams is equivalent to that over consumption streams; and (b) it is through the relaxation of these assumptions that we shall seek to explain some of our results later.

[6]Alternatively, one can assume that future income is subject to risk, that C_t and Y_t are expected values, and that the consumer is risk-neutral.

Table 1

Results of Previous Studies

Study	Percentage
Market rate studies	
Friedman (1957)	30
Landsberger (1971)	9-27
Heckman (1976)	18-20
Rosen (1976)	7.2-8.7
Implicit rate studies	
Hausman (1979)	
Air conditioner purchases	10-39
Leffler and Lindsay (1981)	
Applications to medical school	10
Gilman (1976)	
Decisions to participate in pension plans	1.2-24
Cylke, Goldberg, Hogan, Mairs (1982)	
Response to lump sum vs. installment reenlistment bonuses in Navy	16-20
Direct assessment studies	
Black (1983)	12.5

Market Rate Studies

Market rate studies use a set of assumptions based on economic theory to derive the PDR that would hold for a "rational" economic actor in a given financial position. The logic behind this approach is summarized below.

In addition to these basic behavioral assumptions, three additional assumptions are made: (a) U is concave (i.e., the marginal utility of consumption declines); (b) an individual's ability to borrow is limited only by the present value of his or her future income; and (c) each individual faces a single market rate at which he or she can borrow or lend any amount up to that value.

If these assumptions are all met, then the individual will select the consumption pattern that implies a PDR equal to the market rate of interest.

This conclusion follows from the fact that if, at any time, the individual's PDR is higher than the market rate, that individual can increase his or

her total utility by borrowing against future income at the market rate until, as a consequence of the resulting increase in current consumption and the declining marginal utility of consumption, his or her PDR falls to the market rate. Conversely, if the individual's PDR is lower than the market interest rate, he or she will reduce current consumption through saving, thus increasing his or her PDR until equality between the PDR and the market interest rate is achieved.

This argument, first proposed by Fisher (1930), forms the foundation upon which the studies labeled "market rate analyses" are based. These studies use additional results from economic theory to derive a measure of "permanent income" or life cycle earnings, along with empirical data on relevant interest rates and the availability of credit to predict the PDR that a rational individual would use. Studies of this type include those by Friedman (1957), Landsberger (1971), Mohabbat and Simos (1977), Heckman (1976), and Rosen (1976). The rates derived by these studies range from 7.2% to 30% (see Table 1).

The primary strength of this approach is its firm theoretical basis. Its greatest weaknesses lie in the facts that (a) the assumptions upon which the theory is based--particularly its assumptions with regard to the way individuals develop expectations about their future income stream--lack a strong empirical foundation; and (b) the approach does not provide a solution to the problem of determining which "market interest rate" is relevant to what kind of individual.

In general, we argue that this approach is useful primarily as a means of providing guidance for the specification of models with which to evaluate direct empirical evidence on the PDR and as a framework to explain the products of such models.

Implicit Rate Studies

This approach relies on actual observations of individual decisions to compute the PDR implied by those decisions. The typical procedure is:

1. Collect a representative sample of observations of purchasing, consumption, or other decisions with calculable economic consequences over time.

2. Using the assumption that individuals will maximize the present value of the stream of income (or consumption) that follows from their decisions (and that they accurately understand these consequences), calculate the PDR implied by each individual's decision.

3. Examine the correlations between the implied rates and individual characteristics, usually using a statistical model constructed in accordance with economic theory.

Examples of applications of this approach include studies by Hausman (1979), Gilman (1976), Leffler and Lindsay (1981), and Cylke, Goldberg, Hogan, and Mairs (1982). The PDR predicted by these studies ranges from 1.2% to 39% (see Table 1).

The explicit theoretical economic assumption required by this method is simply that individuals maximize utility subject to income constraints. However, to derive the implications of an observed decision, it is usually necessary to make quite restrictive assumptions about the attributes of the available alternatives. For example, in order to derive the PDR from observations of home air conditioner purchases, Hausman (1979) assumed that the critical attributes of the choice between two air conditioners of a given capacity were limited to price and operating cost (i.e., energy efficiency). Given this assumption and the higher purchase price of energy-efficient air conditioners, the decision to purchase an energy-efficient appliance could be interpreted as a decision to sacrifice current disposable income (paying a higher purchase price) in order to increase future disposable income (paying less in future electricity bills). It is also necessary to make some strong assumptions about the ability (and willingness) of decisionmakers to acquire and accurately analyze the information required to compute the present values of different alternatives. (These assumptions are also required for the "direct assessment" approach described in this section of the report; they will be examined more carefully in the discussion of statistical methodology in the fourth section.)

The strong assumptions required by this approach create two kinds of problems. First, in many cases, the assumptions are of questionable validity, even in the specific context to which they are applied. Second, and perhaps more important, it is possible--indeed likely--that the discount rates used by individuals vary with the kind of decision being made. For instance, the rate applied to a consumption decision (e.g., between durable and nondurable purchases) may be different from that applied to a long-term savings decision (e.g., between self-managed investments and contributions to a pension fund). If this is true, then these assumptions, and the conclusions they generate, become even less reliable when they are applied to a different kind of decision. This problem with generalization of the results, combined with the difficulty of accumulating reliable data on a variety of decision types, is the chief disadvantage of the implicit rate approach.

The most important asset of this approach lies in the fact that it focuses on actual decisions with real economic consequences. It is the preferred approach if researchers can find data that minimize the need to make unrealistic assumptions about decision attributes and individual information-processing capabilities. Unfortunately, data meeting these criteria are very hard to find.

Direct Assessment Studies

This method uses survey data to arrive at PDR estimates. A representative sample is asked to make one or more hypothetical choices among income streams with known implied discount rates. The choices made are then interpreted as indicators of the true discount rate of the respondents. For example, respondents might be asked to indicate whether they would prefer $900 now to $1,000 1 year from now; they are then asked whether they would prefer $1,300 now to $1,500 1 year from now. The present values of the amounts in the first choice are equal at a discount rate of roughly 10%; those in the second choice are equivalent at a rate of 15%. Thus, if a respondent chooses $900 in the first case and $1,500 in the second case, he or she has indicated a PDR of more than 10% but less than 15%.

7

The disadvantages of this method are quite obvious. One problem is that the decision involved is merely hypothetical. The respondent is not required to suffer the consequences of his or her choice, so has no real incentive to consider those consequences with the same care that he or she would exercise if the choice involved real financial trade-offs. This problem can be mitigated by eliciting a series of responses to related questions, and evaluating the consistency across choices of the indicated discount rates. This reduces the probability of weighting purely random responses equally with those that reflect at least some degree of rational consideration.

A second problem with this approach is that responses can be affected by the phrasing of the questions. This is the analog to the "decision attributes" problem with the implicit rate approach. If the respondent's interpretation of the dimensions of the choice is different from that of the researcher, the result will be the same as the overrestriction of decision attributes in the implicit rate case.

The advantages of the direct assessment approach are (a) the choices offered can be tailored to simulate the choices of interest to the researcher; (b) the sample used can be selected to represent the specific population of interest; and (c) careful formulation of questions can minimize the extent to which variations in the ability to acquire and accurately evaluate information about alternatives affect the results.

The Black and ARI studies described in the remainder of this paper are of the direct assessment type. In addition, Gilman (1976) cites direct assessment studies by the Department of Defense, Air Force, and Navy that yielded estimated rates for enlisted personnel ranging from 8.2% to 23%.

ARI SURVEY: PURPOSE, SAMPLE CHARACTERISTICS, AND BASIC RESULTS

In June 1983, ARI was asked to carry out an independent assessment of the PDRs of soldiers, as part of the Army's participation in the Quadrennial Review of Military Compensation (QRMC). The purpose of the study was twofold: (1) to attempt to replicate the results found in Black (1983); and (2) to determine whether a different formulation of the choice set would elicit a different response pattern.

This section provides a brief critique of the Black study, a description of the ARI study, and a comparison of the results of the two studies.

Black Survey

The Black study was an analysis of the responses to a single question included in a 1979 survey of military personnel conducted by the Rand Corporation. The question asked respondents to select one of six retirement plans, assuming that he or she was retiring as an E-7 after 20 years of service. The alternatives ranged from a lump sum payment of $56,150 immediately upon retirement to a lifetime annuity of $5,800 per year. The question specified that all payments would be adjusted for inflation, but would be subject to income taxes. At a discount rate of 9.53%, the present values of the alternative were equal, if variations introduced by different tax liabilities were ignored.

8

In his analysis, Black used two tax assumptions: (a) individuals would be able to calculate accurately their tax liabilities under each alternative; and (b) they would not use income averaging to reduce those liabilities. Under these assumptions, the discount rates at which the various annuities had present values equal to the lump sum ranged from 13.4% (for the lifetime annuity) to 20.2% (for a 2-year annuity paying $32,350 per year). Under this interpretation, a respondent selecting the lifetime annuity was indicating a PDR of less than 13.4%, while a selection of the lump sum implies a rate in excess of 20.2%. After analysis of the results, using a binomial logit model, Black arrived at (real) PDR estimates for Army enlisted personnel. They ranged from 9.5% to 14.5%, depending on individual characteristics. The predicted rate for the "average" enlisted person was 12.5%.

This PDR estimate is somewhat lower than most earlier estimates but it is well within the "reasonable" range predicted by economic theory. However, the analysis suffers from two serious problems. First, the use of a single question provides no way to sort out purely random responses from those arrived at after some serious consideration of the choices offered. Second, the tax assumptions made yield the highest imputed discount rates. If respondents are assumed either to ignore tax consequences or to accurately assess those consequences and take advantage of income averaging, the rates implied by the responses to the Rand question are substantially lower. Furthermore, the choices offered in the Rand survey do not accurately mimic the alternatives most likely to result from changes in retirement policy. Those changes will probably involve trade-offs between current pay and retirement benefits rather than changes in the length of time over which retirement benefits are paid.

ARI Survey

In light of these issues, ARI designed a set of questions that would (a) allow responses to be checked for consistency; (b) eliminate, to the extent possible, the need to make assumptions about the degree of financial sophistication of the respondents; and (c) simulate the kind of trade-offs between pay and retirement income that are most prominent among the compensation alternatives currently being considered. (The texts of both the ARI and Rand questions are presented in Appendix A.)

Because of time constraints, we elected to "piggyback" a set of questions onto an existing survey--the 1983 ARI Exit Survey--rather than develop and administer a separate instrument. This survey was administered to 6,498 soldiers undergoing processing prior to a permanent change of station (PCS) or exit from the service (ETS). To eliminate confounding factors, the sample was limited to soldiers in grades E-3 to E-9 who were either undergoing a PCS or leaving the Army at the expiration of their first term of service. This resulted in an "eligible" sample of 3,744 soldiers, 38% of whom were in the PCS category. The sample was further reduced for analysis of the linked binary questions by the requirement that the set of responses to the three questions be internally "consistent." For instance, responses indicating a rate of more than 15% on one question and less than 10% on another were rejected. Approximately 10% of the 3,744 cases were eliminated for this reason. Finally, in order to carry out the multivariate analysis, observations containing missing data for any of the explanatory variables were eliminated. The final sample size for the analysis was 2,438.

The resulting sample is different from the general enlisted population. However, as indicated by the comparative statistics displayed in Table 2, the disparity is not severe. Females, single soldiers, and personnel in low grades are somewhat overrepresented in the ARI sample, although it is fairly representative with respect to education level and race. On the basis of the results of earlier studies, the effect of the sample bias on sex, marital status, and grade can be expected to increase the average PDR of the sample. Since the rates estimated in the ARI survey are substantially lower than those found by previous studies, these effects do not appear to provide an explanation for the disparity of our findings.

Table 2

ARI Sample: Descriptive Statistics

	Eligible sample (N = 3,744)		Logit sample (N = 2,438)		Army population Grades E-3 to E-9	
	%	N	%	N	%	N
Race						
White, not Hispanic	57.3	2,101	61.6	1,503	59.3	332,301
Black	33.5	1,229	29.5	719	32.2	180,306
Hispanic	8.2	304	7.9	193	4.4	24,901
Other	.8	30	.9	23	4.1	22,961
Missing data		80		0		NA
Education						
Non-HS graduate	5.0	176	3.8	90	4.8	27,449
GED	12.2	427	11.4	279	12.6	70,792
At least HS degree	82.7	2,901	84.8	2,069	82.5	462,228
Missing data		240		0		NA
Sex						
Male	87.4	3,262	86.0	2,096	90.1	504,859
Female	12.6	469	14.0	342	9.9	55,610
Missing data		13		0		NA
Marital status						
Married	51.9	1,944	50.6	1,233	57.1	319,988
Single, widowed, or divorced	48.1	1,800	49.4	1,205	42.9	240,720
Grade						
E-3	13.5	505	13.2	323	17.9	100,224
E-4	54.2	2,030	51.8	1,262	32.4	181,400
E-5	20.1	752	20.7	504	21.6	120,800
E-6	8.2	308	9.6	233	15.6	87,258
E-7	3.2	123	3.9	94	9.1	50,786
E-8	.6	24	.8	20	2.8	15,722
E-9	.1	2	.1	2	.7	4,179

Comparison of Basic Results

Table 3 displays the distribution of responses to the Rand version of the multiple choice question. Table 4 summarizes the responses to the ARI version, and Table 5 provides the results on the three linked binary questions asked by ARI.

Table 3

Summary of Responses: Rand Survey

Schedule	Annual amount	Implied rate (SRA assumptions)[a]	Response frequency
Life annuity	$ 5,800	13.4%	57.9%
20-year annuity	6,600	14.4%	8.9%
10-year annuity	9,140	16.8%	6.3%
5-year annuity	14,810	20.3%	4.1%
2-year annuity	32,350	20.2%	2.6%
Lump sum	56,150	--	20.2%

[a]Assumptions: Respondents accurately estimate tax liability under each alternative, using 1978 rates. Respondents do not use income averaging.

Table 4[a]

Summary of Responses: ARI Survey (Multiple Choice Question)

Schedule	Annual payment[b]	Implied rate (SRA assumptions)[c]	Response frequency
Life annuity	$ 8,900	13%	35.8%
20-year annuity	10,494	17%	22.4%
10-year annuity	14,532	17%	9.7%
5-year annuity	24,547	20%	7.0%
2-year annuity	51,436	20%	4.4%
Lump sum	89,278	--	20.4%

[a]2.9% of eligible responses eliminated because of missing data. Net sample size = 3,744.

[b]Payments adjusted upward from Rand rates to reflect inflation.

[c]Assumptions: Respondents accurately estimate tax liability under each alternative, using 1978 rates. Respondents do not use income averaging.

Table 5

Summary of Responses: ARI Survey (Linked Binary Questions)

Salary	Annual retirement payment	Implied rate	Response frequency
$15,000	$ 4,5	5%	82.8%
15,000	9,400	5-10%	8.7%
15,000	14,600	10-15%	4.0%
20,000		15%	4.5%

Looking first at the multiple choice question, we see that the distribution of responses among the various annuities is shifted toward the shorter-term, high-discount option in the ARI sample--64.2% of the ARI respondents indicate a rate in excess of 13%, as opposed to 42.1% of respondents in the Rand sample. However, the percentages of respondents indicating a preference for one of the annuities instead of the lump sum (thus indicating a PDR of less than 20%) are virtually identical across the two samples. If respondents do not follow Black's tax assumptions, the patterns are very similar. In this case, the question becomes binary, and the implications are that 20.2% (Rand) vs. 20.4% (ARI) have PDRs greater than 9.5%. In any case, while the results are not identical in all respects, they are reasonably consistent.

In Table 5, however, some very strong differences in the response patterns emerge. The consistent responses to the linked binary questions imply that 82.8% of the ARI sample have PDRs of less than 5%, while 64.2% of the same sample indicate rates of more than 13% on the multiple choice question. On the other end of the scale, 20.4% of the sample indicate rates in excess of 20% on the multiple choice question, but only 4.5% show rates of more than 15% on the linked binary questions. These differences become somewhat less pronounced, but remain significant even if Black's tax assumptions are eliminated. (Without these assumptions, the relevant comparison is 91.5% with rates less than 10% vs. 79.6% with rates less than 11%). Thus, the ARI respondents indicate rates somewhat higher than those indicated in the Rand sample when a single multiple choice question is used, but consistently show substantially lower rates on the linked binary questions.

As Table 6 reveals, these inconsistencies cannot be readily correlated with the characteristics of individual respondents. Individuals who indicated low rates on the binary questions were as likely to select the lump sum option on the multiple choice question as those individuals who indicated high rates. These correlations were also examined within groups defined on the basis of age, sex, race, and PCS vs. ETS status; no relationship between these variables and response patterns could be discerned.

These results are limited by the fact that they allow an examination of only binary relationships in the data. To look at more complex linkages, it is necessary to employ more sophisticated statistical tools than those afforded

12

by simple cross-tabulations. The following section briefly describes such a model and compares the results obtained by applying the model to the ARI responses with those results obtained by Black.

Table 6

Relationship of Multiple Choice to Linked Binary Rates

M-C rate	L-B rate	Observed frequency	Expected frequency	Percent deviation	Cell Chi-square
<13.4%	<5%	865	825.9	4.7%	1.9
<13.4%	>5%	131	170.1	-23.0%	9.0
>13.4%	<5%	1,159	1,198.1	-3.3%	1.3
>13.4%	>5%	286	246.9	15.8%	6.2

Overall chi-square: 18.4 (Probability = .0001)

M-C rate	L-B rate	Observed frequency	Expected frequency	Percent deviation	Cell Chi-square
<13.4%	<10%	933	908.7	2.7%	.7
<13.4%	>10%	63	87.3	-27.8%	6.3
>13.4%	<10%	1,294	1,318.3	-1.8%	.4
>13.4%	>10%	151	126.7	19.2%	10.5

Overall chi-square: 12.5 (Probability = .0004)

M-C rate	L-B rate	Observed frequency	Expected frequency	Percent deviation	Cell Chi-square
<13.4%	<15%	962	951.5	1.1%	.1
<13.4%	>15%	34	44.5	-22.7%	2.5
>13.4%	<15%	1,370	1,380.5	.7%	.1
>13.4%	>15%	75	64.5	15.4%	1.7

Overall chi-square: 4.4 (Probability = .0367)

M-C rate	L-B rate	Observed frequency	Expected frequency	Percent deviation	Cell Chi-square
<22.4%	<15%	1,797	1,788.4	.5%	0
<22.4%	>15%	75	83.6	-10.7%	.9
>22.4%	<15%	535	543.6	-1.7%	.1
>22.4%	>15%	34	25.4	36.0%	2.9

Overall chi-square: 3.9 (Probability = .0464)

13

LOGIT ANALYSIS

The simple statistics displayed in Tables 3 through 6 provide general information on the range of implied discount rates in the sample population, but they are limited in two respects. First, they are not very useful for examining how these rates vary with individual characteristics; therefore they are of little use in predicting how different kinds of soldiers might respond to a contemplated change in compensation policy. Second, the raw statistics can be only roughly compared with the predictions of economic theory and the results of other studies. One means of overcoming these limitations is to construct a model of the process that determines the PDR, and statistically estimate the parameters of that model. A statistical methodology well-suited to this purpose is logit analysis; this is the technique applied in both the ARI and Black studies. A brief description of this approach follows.

Logit analysis allows unbiased and consistent parameter estimates to be obtained when the dependent variable in a model is qualitative and discrete rather than quantitative and continuous. The approach can be used in cases where the dependent variable takes on several values; for our purposes, however, a binary dependent variable provides a sufficient definition of behavior. The application of this model involves the following sequence:

1. We group the observed choices in the sample into two categories--those indicating a rate greater than some convenient cutoff point, and those indicating a rate less than or equal to that point. (In this analysis, the cutoff points used were 13% for the multiple choice question and 10% for the binary questions. Note, however, that the choice of a cutoff point is arbitrary; if the assumptions of the model are satisfied, a different choice would not change the results.)

2. We assume that the observed choice of a respondent is a function of the difference between his or her true discount rate and the rate implied by his or her choice. In other words, the lower a person's true PDR, the more likely he or she is to choose the option with the lowest implied rate. Specifically, if we define D as the cutoff rate, D_i as individual i's true PDR, and $C_i = (1,0)$ if i chooses the (high, low) option, then our assumption is:

$$\text{Prob}(C_i = 1) = f(D_i - D) \tag{4}$$

3. We further assume that $\text{Prob}(C_i = 1)$ follows a logistic distribution

$$\text{Prob}(C_i = 1) = \frac{1}{1 + e^{-(D_i - D)}} \tag{5}$$

In other words, the probability of selecting the high-discount option is .5 when the individual's discount rate is exactly equal to the cutoff point, approaches 0 as D_i becomes smaller, and approaches 1 as D_i becomes larger. (See Figure 1.)

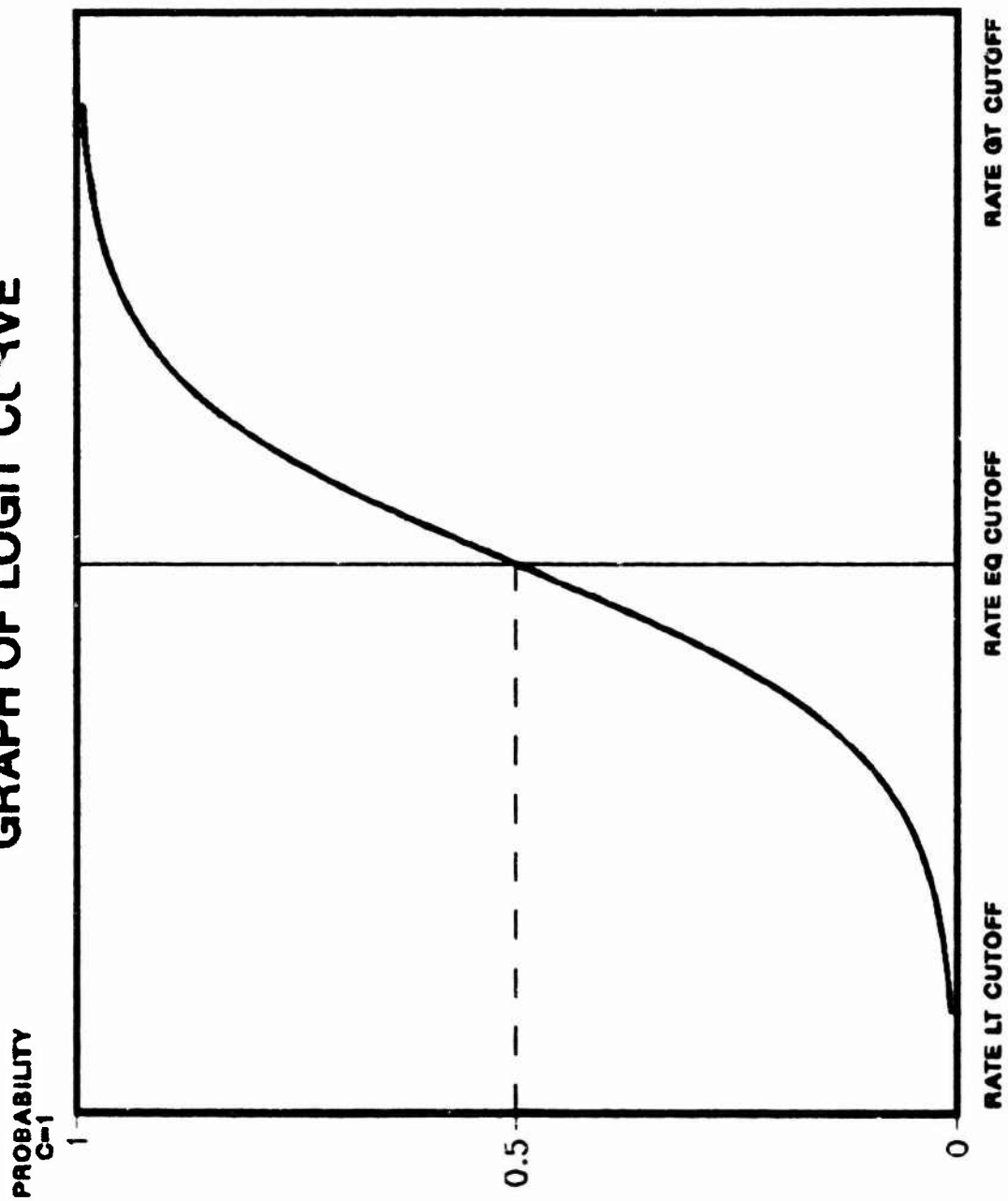# FIGURE 1
GRAPH OF LOGIT CURVE

Figure 1. Graph of logit curve.

15

4. Finally, we assume that i's true PDR (which is not observed directly) is a linear function of K observable characteristics, x_{i1}, x_{i2}, --, x_{iK} that is,

$$D_i = \sum_{j=1}^{K} B_j x_{ij} = Bx_i \tag{6}$$

where $x_{io} = 1$, B is a 1 x K row vector, and x_i is K x 1.

5. These assumptions give us

$$Prob(C_i = 1) = \frac{1}{1 + e} - (Bx_i - D) \tag{7}$$

6. By coding the observed choices as ones or zeros, we can estimate the above equation and obtain estimates of the elements of B. These estimates can, after the appropriate transformations,[7] be interpreted as the differential effects of individual characteristics on the PDR.

There are a number of difficulties and limitations to this procedure, some of which are discussed in treatments by Pindyck and Rubenfeld (1981) and Amemiya (1981), but the most relevant difficulty to the current treatment lies in the problem of specifying the elements of X--that is, in defining the set of observable characteristics that determine an individual's true discount rate. Our efforts in this regard were directed primarily by our desire to achieve results that could be compared to those found by Black. Unfortunately, the Exit Survey data did not include all of the variables needed to duplicate the equation estimated by Black. Most importantly, we were not able to obtain data on the levels of liquid assets and debts of the respondents, and economic theory would lead one to expect both of these characteristics to be important determinants of the PDR. As a result of these constraints, our logit results are of interest primarily to the extent that the coefficients agree or disagree in sign with the coefficients estimated by Black.

Table 7 displays the estimated coefficients for both types of question in the ARI analysis, as well as those found by Black. For purposes of comparison, we have also included the coefficients estimated by Gilman (1976). The model uses only sex, race, marital status, and income to explain variation in discount rates, and its coefficients were estimated from a sample of employees of

---

[7]The raw maximum likelihood coefficients are obtained, using a standard logistic distribution. Thus, all estimated coefficients are implicitly weighted by pi/1.73 sigma. In order to obtain meaningful predicted values for the discount rate, it is necessary to multiply the coefficients by sigma 1.73/pi. Unfortunately, it is not possible to obtain an estimate of $\underline{r}$ directly in the multivariate case because the addition of the parameter results in an underidentified system. To deal with this problem, we followed the procedure used by Black, estimating a univariate version of the model using paygrade as the explanatory variable, and deriving an estimate of sigma. The resulting estimate of $\underline{r}$ was .0512.

Table 7

Determinants of the Personal Discount Rate: Estimates from Three Analyses

	ARI		Black	Gilman
	Model I	Model II	Model III	Model IV
	Linked binary	Multiple choice	Multiple choice	Empirical assessment
INTERCEPT[a]	.0125**	.1404**	.1522**	.429
FEMALE	-.0152**	-.0020*	-.0059**	.015**
BLACK	.0079*	.0055	.0126**	.015**
HISPANIC	.0243**	.0012	.0046	NA
SEP/DIV	NA	NA	.0104**	NA
MARRIED	-.0053**	-.0033	NA	-.00075**
INCOME[b]	NA	NA	.0000	-.0000062**
LOGRADE[c]	.0137**	.0051*	NA	NA
TECH OCC[d]	NA	NA	-.0063**	NA
NHS	NA	NA	.0094**	NA
GED	NA	NA	.0058**	NA
NHS/GED	.0049	.0027	NA	NA
COLL[e]	NA	NA	.0029**	NA
HOMEOWNER	NA	NA	.0004	NA
YEARS SERVICE	NA	NA	-.0014**	NA
REMAINING SERVICE[f]	NA	NA	-.0013**	NA
LEAVING[g]	.0131**	.0024*	NA	NA
DEBT[h]	NA	NA	-.0024*	NA
ASSETS[i]	NA	NA	-.0136**	NA
KNOWLEDGE OF RETIREMENT[j]	NA	NA	.0004**	NA

*Indicates that the coefficient was statistically different than ----.

[a]The intercept term in all models includes the relevant "cutoff point."

[b]Black used the ratio of military pay (in $1,000's) to family size for this variable. Gilman used income in dollars.

[c]Equals 1 for respondents at grade E-4 or less, and 0 otherwise.

[d]Equals 1 for individuals in military specialties such as electronics, communications and intelligence, electrical and mechanical repair, support and administration, and medical and dental care.

[e]Equals 1 for individuals with at least some education beyond high school.

[f]Calculated by Black as the difference between current years of military service and expected date of exiting the service.

[g]Equal to 1 for those respondents who were leaving the service at the expiration of their first term of service.

[h]Equal to 1 if the individual indicated responsibility for nonmortgage debt in excess of $500.

[i]Equals 1 for enlisted personnel with any liquid assets.

[j]Value was the difference between the respondent's estimate of the percentage of basic pay used to determine retirement pay after 26 years of service and the actual percentage (65%).

nonprofit corporations. The estimates are based on observations of employee participation in company retirement plans and other investment programs. The resulting model differs markedly from both the Black and ARI models in several respects.

The Gilman model predicts rates that are ore variable than those predicted by the other formulations presented her. Its projections are highly sensitive to income and age, and vary from roughly 2% (for a 35-year-old white male earning $25,000) to about 25% (for an 18-year-old unmarried black female earning $8,000). Interestingly, the Gilman model would predict a rate of 14.7% for the average soldier in the ARI sample. This rate is very close to the mean predicted rate of 14.2% generated by Model II in Table 7, and is also quite similar to the mean of 12.5% from the Black model. On the other hand, the rates predicted from the linked binary model (Model I) are substantially lower than those resulting from any of the other models, with a mean predicted rate of less than 2%. These results are also inconsistent with the predictions of economic theory, which suggests that any rate lower than the real market rate on savings is irrational. We are thus left with two possibilities: (a) there is a significant flaw in the ARI approach that leads to a downward bias in the derived estimates; or (b) the results are accurate, but the decision process used is different from the one assumed by economic theory. The concluding section of this paper will argue that each of these alternatives provides a reasonable explanation for our results, and that additional research is necessary to assess their validity.

A second point of disagreement among the models is their predictions with respect to the directional effect of gender. Gilman's model indicates that women have higher expected PDRs than men, while all of the other models predict the opposite effect. Conventional wisdom would lead one to expect this coefficient to be positive, as predicted by the Gilman model. This is based on the assumption that women generally earn less than men, and that they are likely to have less borrowing power--factors that would tend to increase the PDR. The fact that this coefficient is consistently negative in the ARI and Black equations may be due to the fact that male/female earnings differentials are not as great among service members as they are in the civilian sector. It also may be due to the diminishing gap in both earnings and borrowing power between 1976 and 1980. In any case, this difference suggests that the prediction of the Gilman model with respect to the discount rates of women is open to question.

Finally, if we ignore the absolute magnitude of the predicted rates, we find agreement in sign among the coefficients shared by the ARI and Black models. This suggests that there are some important similarities in the process being measured by all three of these models. However we choose to interpret the dependent variable, these models agree that it is affected in the same direction by race, marital status, sex, and high school completion status. The points of disagreement with respect to direction (on the dummy for whether or not the individual is in an occupation classified as "technical" [TECH OCC], and the one for "some college" [COLL]) occur in cases where the ARI coefficients are not significantly different from zero. The only other significant difference relates to the effect of income. Here, the somewhat surprising lack of an effect indicated by the Black model may be due to collinearity between this variable and other variables included in the model (e.g., liquid assets and homeownership).

18

To test the difference in rates between respondents who were leaving the service and those who were not, we included the variable "Leaving" (equal to 1 if the respondent was leaving the service). The positive effect of this variable suggests that individuals who intend to reenlist may have lower discount rates than individuals who do not.

In summary, there is a substantial degree of agreement among all models as to the differential effects of the variables they share, with the exception of gender. Thus, if any of the models are correct, one would expect a reduction in retirement pay to have a more pronounced negative effect on reenlistment among older, white, high-income (i.e., high-grade) soldiers than among young, black, low-income soldiers. However, the models disagree widely with respect to the magnitude of these effects.

CONCLUDING REMARKS AND POLICY IMPLICATIONS

This section will proceed as follows: First, it will explore some of the reasons for the divergence of the ARI results from those of earlier studies and from the expectations produced by economic theory. Second, the policy implications of these results will be discussed. Finally, it will set out some plans and suggestions for further work in this area.

Sources of Variation in Results

The most intriguing aspect of the results described in the previous section is the remarkably low range of rates elicited by the linked binary questions on the ARI survey. If these rates accurately reflect the preference of soldiers for current vs. deferred income, then the most widely used models of reenlistment behavior are likely to seriously underestimate the negative effects of reductions in military retirement pay.

Clearly, it would be desirable to demonstrate that either (a) these results are valid, so "standard" estimates of the PDR of soldiers should be revised downward; or (b) the results are an artifact of the research design and provide only cautionary evidence of the sensitivity of PDR estimates to the methods chosen to obtain them. Unfortunately, plausible explanations leading to each of these conclusions exist; further research will be required to choose between them. These explanations are presented in the following paragraphs.

> Hypothesis 1: The ARI estimates are biased downward by the formulation of the survey questions.

The following aspects of the survey questions could cause a downward bias:

1. The choices are expressed in annual, rather than monthly or weekly amounts. If the respondents are accustomed to calculating their income in smaller units, the use of annual equivalents may distort responses through a mechanism often called "money illusion"—it may seem that $15,000 per year is a larger amount than $290 per week. If this is true, the effect is to increase perceived current wealth in the hypothetical situation; thus, it tends to reduce discount

19

rates. This effect may be further exaggerated if individuals over-
estimate the rate of decline in the marginal utility of income--
i.e., if they underestimate the rate at which "needs" tend to grow
as income increases.

2   ` ` .i if money illusion is not a problem, the same situation would
     ~pply if individuals underestimate their own current income--by
     undervaluing benefits and allowances, for example. This would have
     the effect of increasing the apparent value of the low salary option
     in the hypothetical situation, with the same consequences for the
     implied PDR as those noted above.

3.   There is considerable evidence that most people are risk averse--
     that is, given a choice between an assured payment of $X and a gam-
     ble with expected value of $X, most people choose not to gamble.
     Such individuals will discount future benefits not only because of
     the earning power of capital, but also because of the uncertainties
     introduced by the passage of time.

In addition, there is empirical evidence (see Kahneman, Slovic, & Tversky,
1982) that individuals do not calculate the "costs" of uncertainty in the same
way across all kinds of gambles. In particular, individuals appear to "over-
value" absolute certainty--that is, they tend to exhibit higher degrees of
risk-averseness when faced with a choice between certain gain and a gamble
with a positive expected value than they exhibit when faced with a choice be-
tween two positive gambles.[8]

The linked binary questions offer no risk-free alternatives--the only
choices are among streams of different lengths. The multiple choice question,
on the other hand, does offer one choice--the lump sum--that is effectively a
certainty. If the effect observed by Tversky and Kahneman is operative, then
this difference would tend to produce higher apparent rates when the multiple
choice question is used.

It is important to note, however, that none of the actual choices likely
to be faced by soldiers are free of uncertainty. Thus, to the extent that the
"certainty effect" is an important factor, choices (real or hypothetical) that
involve trade-offs between certainties and gambles may be misleading.

Hypothesis 2:   The assumptions of the conventional economic
model are overly restrictive.

If the low rates indicated by the ARI survey are accurate, then it must
be true that one or more of the assumptions in the basic economic model of in-
dividual choice is not satisfied. We shall argue here that this may indeed be
the case. In particular, we suggest:

---

[8]It should be noted that this effect seems to operate in opposite directions,
depending on whether the comparison is made for gains or losses. People tend
to be more risk-<u>seeking</u> if given a choice between a certain loss and a gamble
with a negative expected value.

1. The assumption that all forms of savings are costless (or equally costly) is invalid.

2. As a consequence, some forms of saving will be preferred to other forms yielding the same pecuniary return.

3. Savings in the form of automatic deferments of income will be preferred, ceteris paribus, to self-enforced savings.

4. The low rates indicated by the responses to the ARI linked binary questions are not inconsistent with rational, utility-maximizing behavior, therefore, and may not be rejected as unreasonable for that reason.

A number of models of individual choice that allow for this modification of the conventional assumptions have been suggested by both economists and psychologists--Thaler and Sheffrin (1981) and Tversky and Kahneman (1981), for example. The idea shared by these models is that making and implementing decisions are intrinsically costly--that is, the decision itself imposes "transaction costs" independent of its economic or other consequences. These may include costs for information acquisition and processing, monitoring, and "enforcement," among other things.

Intuitively, we can think of these costs as the time and energy required to identify and evaluate alternative investment opportunities, evaluate consumption needs, and force oneself to set aside income for investment purposes. The classical economic model ignores these costs and assumes that savings are savings, no matter how they are achieved--whether by payroll deductions or by setting aside part of one's weekly earnings.

If we include these costs in our model, certain behaviors that are "irrational" under the traditional model can be explained without violating the utility-maximization assumptions. Among these are the use of rules and incentives that result in "suboptimal" decisions, but minimize transaction costs. An example of such a rule is one that prohibits dissaving and results in borrowing at 20% on a credit card while maintaining savings that earn 5%. Another, and more relevant, possibility is that individuals may be willing to "pay" a fee to have someone else "enforce" their savings decisions--e.g., to accept a return lower than their PDR on retirement contributions withheld from pay.

Under this scenario, the respondents to our survey may in fact have PDRs well in excess of 5%, but still prefer the retirement plan returning 5% to a higher salary and self-enforced savings. If this is true, then a model that predicts individual decisions strictly on the basis of the "true" PDR will be incorrect because it is misspecified.

Note that this alternative model can also be used to explain PDRs that appear to be higher than expected on the basis of the standard model; thus,

21

they may generate explanations for estimates that vary from the predictions of theory in the opposite direction from ours.[9]

Policy Implications

This research has shown that the PDR has varied considerably in the literature--from less than 1% to over 30%. These estimates are also very sensitive; changing only the tax assumptions in one study lowered the discount rate from 12.5% to 4.7%.

The rates found in both the ARI and Rand surveys imply that PDRs could be much lower than the 16.8% used in current retention models. The responses to the questions show evidence that soldiers place a high value on long-term benefits.

All major studies agree on the impact of many personal characteristics on discount rate preference. Experienced personnel, nonminorities, married individuals, and high school graduates tend to have lower discount rates. Hence, a retention program based on immediate bonuses is likely to be most favorable to inexperienced personnel, minorities, singles, and nongraduates.

These findings suggest extreme caution in changing the retirement system. Given the sensitivity of various models to the PDR (e.g., Warner, 1979), new programs should differ as little as possible from the current system. Dramatic changes could unexpectedly and drastically alter the personnel structure of the Army.

Estimates of the PDR that are based on survey data are highly sensitive to the way in which the choices are formulated and the economic, information-processing, and statistical assumptions that are imposed in order to interpret the responses. Therefore, it is important that policymakers recognize that this uncertainty is not accounted for by using statistically estimated "confidence intervals," since the estimates of these ranges are themselves conditional on the validity of the assumptions used to estimate the models. Furthermore, while it is true that estimates based on actual, rather than hypothetical, data are not subject to the same uncertainties, a translation of observed behavior into an indicator of the PDR requires assumptions about the way individuals gather and process information. These assumptions are just as sweeping as those required for the direct-response models. It is prudent, therefore, to assume that the reliability of empirically estimated rates is dependent on the similarity of the decision upon which the estimates are based to the decision that is being predicted.

Areas for Further Research

Two areas for further research are suggested. The first involves an extension of the ARI research, with a reformulation of the questions to address

---

[9]For example, in choices between a large lump sum and an equivalent annuity, the presence of transaction costs might result in discount rates that are higher than the relevant market rate.

the issues identified in this section and a survey that provides more complete information on variables such as income, assets, and debt. Ideally, such a survey would be accompanied by an "implicit rate" analysis of an appropriate "real-world" decision by the respondents.

The second promising avenue is that of further developing, and then testing, a "transaction cost" model of individual choice. For the most part, the work done so far in this area is exploratory and speculative in nature, and is supported primarily by anecdotal evidence. However, the groundwork has been laid for the formulation of hypotheses that can be empirically tested. Further work in this direction could provide information that would be valuable not only in the narrow area of assessing discount rates, but also in better understanding individual decision-making processes in other areas of critical importance to the Army. This direction seems to be a particularly appropriate one for ARI because it demands the application of insights provided by both the psychological theory and the economic theory.

REFERENCES

Amemiya, T. (1981). Qualitative response models: A survey. Journal of Economic Literature, 19, 1483-1536.

Black, M. (1983). Personal discount rates: Estimates for the military population. Study prepared for Fifth Quadrennial Review of Military Compensation.

Coffey, K. (1983). Statement to Subcommittee on Military Personnel and Compensation, House Committee on Armed Services, U.S. House of Representatives. Washington, D.C., July 14.

Cylke, S., Goldberg, M., Hogan, P., & Mairs, L. (1982). The personal discount rate. Evidence from military career decisions. Department of the Navy, Economic Analysis Branch (OP-162).

Dale, C., & Hill, L. G. (1984). Military and civilian lifetime earnings comparisons. Army Research Institute Technical Report 620.

Fisher, I. (1930). The theory of interest. New York: Macmillan & Company.

Friedman, M. (1957). A theory of the consumption function. Princeton: Princeton University Press.

Gilman, H., Jr. (1976). Determinants of implicit discount rates: An empirical examination of the pattern of voluntary pension contributions of employees in four firms. Center for Naval Analyses Research Contribution 309.

Hausman, J. (1979). Individual discount rates and the purchase and utilization of energy-using durables. Bell Journal of Economics, 10.

Heckman, J. (1978). A life cycle model of earnings, learning and consumption. Journal of Political Economy, 84.

Kahneman, D., Slovic, P., & Tversky, A., eds. (1982). Judgment under uncertainty: Heuristics and biases. Cambridge: Press Syndicate of the University of Cambridge.

Landsberger, M. (1971). Consumer discount rates and the horizon: New evidence. Journal of Political Economy, 79.

Leffler, K., & Lindsay, C. (1981). Student discount rates, consumption loans, and subsidies to professional training. Journal of Human Resources, 16(3), 468-476.

Mohabbat, K. A., & Simos, E. O. (1977). Consumer horizon: Further evidence. Journal of Political Economy, 85(1), 851-858.

Pindyck, R. S., & Rubinfeld, D. L. (1981). Econometric models and economic forecasts (2nd ed.). New York: McGraw-Hill.

Rosen, S. (1976). A theory of lifecycle earnings. Journal of Political Economy, 84, 845-867.

Thaler, R., & Sheffrin, H. M. (1981). An economic theory of self control. _Journal of Political Economy_, _89_.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. _Science_, _211_.

Warner, J. T., (1979). Alternative military retirement systems: Their effects on enlisted retention. Center for Naval Analyses Report CRC 376.

RAND MULTIPLE CHOICE QUESTION

Suppose you retired with 20 years of service at an E-7 (enlisted) or 0-5 (officer) pay grade and you had to choose the way in which your retirement benefits would be paid. Which of the following would you choose? The payments listed below would be the initial payment schedule; however, your future payments would be adjusted for inflation and taxed in the same way as the current retirement system.

A lifetime annuity of	$ 5,800/yr
A 20-year annuity of	6,600/yr
A 10-year annuity of	9,140/yr
A 5-year annuity of	14,810/yr
A 2-year annuity of	32,350/yr
A lump sum payment at retirement of	56,150

ARI QUESTIONS

The questions from the ARI Exit Survey pertaining to the discount rate analysis were questions numbers 123-125 and 127. Question 124 is the multiple choice question comparable to the earlier Rand question. The linked binary choice questions are 123, 125, and 127.

123. Suppose you are offered a job which will last for ten years. You cannot be fired and you are not allowed to quit. All payments, both during the job and after it is over, are tax-free, and will be adjusted to cover inflation.

You can choose one of two wage plans:

PLAN A pays $20,000 per year for ten years on the job, nothing after that.

PLAN B pays $15,000 per year for the ten years on the job plus $4,500 per year for the 20 years after the job is over.

Which plan would you choose?

A. Plan A
B. Plan B

124. Suppose you had put in your 20 years and were planning to retire at pay grade E-7 and you had to choose the way in which your retirement would be paid.

The payments listed are the amounts you would get in the first year of retirement; however, all payments after the first year would be adjusted for inflation and all payments, including the first year, would be taxed as regular income.

Which of the following would you choose?

A. $8,900/year for life
B. $10,494/year for 20 years
C. $14,532/year for 10 years
D. $24,547/year for 5 years
E. $51,436/year for 2 years
F. A lump sum of $89,278 at retirement

125. Suppose you are offered a job which will last for ten years.
      You cannot be fired and you are not allowed to quit.
      All payments, both during the job and after it is over, are tax-free,
      and will be adjusted to cover inflation.

      You can choose one of two wage plans:

           PLAN A   pays $20,000 per year for the ten years on the job,
                    nothing after that.

           PLAN B   pays $15,000 per year for the ten years on the job
                    plus $9,400 per year for 20 years after the job is
                    over.

      Which plan would you choose?

      A. Plan A
      B. Plan B

127. Suppose you are offered a job which will last for ten years.
      You cannot be fired and you are not allowed to quit.
      All payments, both during the job and after it is over, are tax-free,
      and will be adjusted to cover inflation.

      You can choose one of two wage plans:

           PLAN A   pays $20,000 per year for the ten years on the job,
                    nothing after that.

           PLAN B   pays $15,000 per year for the ten years on the job
                    plus $14,600 per year for 20 years after the job is
                    over.

      Which plan would you choose?

      A. Plan A
      B. Plan B